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Prohibiting Inverse Scope: An Experimental Study of Chinese vs. English

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Quantifier scope is an interface phenomenon that raises important questions concerning the processing of not only monolingual but also bilingual speakers. In this paper, we build upon the findings by Scontras et al. (to appear) by investigating and comparing the scope interpretations available for doubly quantified sentences such as *Every shark attacked a pirate* not only in Mandarin Chinese and English, but crucially in heritage Mandarin. Our results reinforce that (i) Mandarin does not exhibit inverse scope; and (ii) English exhibits inverse scope even when a quantifier is embedded in a relative clause, thus supporting the head-raising analysis of relativization (Vergnaud 1974, Kayne 1994). They also prove that (iii) heritage Mandarin does not demonstrate inverse scope, which conforms to the Processing Scope Economy principle (Anderson 2004).

Keywords: quantifier scope, Mandarin Chinese, heritage Mandarin, relativization

1 Introduction

English sentences with more than one quantificational expression exhibit scope ambiguities (May 1977). For instance, (1) has two readings: surface scope (1a) and inverse scope (1b). Likewise, (2) also has two readings:

- (1) Every shark attacked a pirate.
 - a. Surface scope (*every* > *a*): For every shark, there is a pirate that it attacked
 - b. Inverse scope (*a* > *every*): There is a pirate such that every shark attacked him
- (2) A shark attacked every pirate.
 - a. Surface scope (*a* > *every*): There is a shark such that it attacked every pirate
 - b. Inverse scope (*every* > *a*): For every pirate, there is a shark that attacked him

Despite its observed preference for surface interpretations (Tunstall 1998, Anderson 2004, among others), English is a language that employs Quantifier Raising (QR) to generate inverse scope in

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doubly quantified sentences. Crucially, QR’s mapping to Logical Form need not remain faithful to the scope relations expressed in the surface string.

Scope calculations are notoriously difficult and are also known to be quite fragile. This is not surprising given that scope readings bring together at least three levels of representation: syntax, semantics, and pragmatics. Preferences and dispreferences in scope readings are often accounted for under the notion of pragmatic calculus (Musolino and Lidz 2006); the leading idea is that listeners start with the assumption that each interpretation is mapped to an unambiguous pattern, and only give up on that assumption if forced to do so. To put it differently, listeners assume a more economical model (one pattern: one interpretation) unless forced to map one pattern to more than one interpretation.

Recently, this idea was tested, in a novel way, on bilingual populations. Lee et al. (2011) investigated the possible effect of bilingualism on scope interpretation in English, focusing on early sequential bilinguals (children and adults) who had learned Korean before they learned English but who were dominant in English at the time of testing. The authors reported that early exposure to Korean seemed to interfere with learners’ scope calculation in English. In their interpretation of sentences such as (3), these sequential bilinguals strongly preferred the full-set interpretation, parallel to what is observed for Korean (where such an interpretation is motivated by the surface word order), and did not demonstrate the partitioned-set interpretation that is otherwise characteristic of English.

- (3) Robert did not cut down all the trees.
- a. Full set interpretation (*all* > *not*): Robert did not cut down any trees.
 - b. Partitioned set interpretation (*not* > *all*): Not every tree was cut down by Robert.

Crucially, these bilinguals evidence a grammar of scope that lacks ambiguity: like in Korean, only one reading is possible. The mechanism that yields the availability of (3a) (and not (3b)) remains unclear. It is likely the case that the reading in (3a) results from an obligatory definite interpretation of the object, *all the trees*, forcing it to scope above negation. We do not yet know whether in Korean the situations in which none of the trees were cut are judged against an interpretation that is licensed by the grammar (*all* > *not*) or as a subcase of the *not* > *all* reading. Lee et al. (2011) only tested quantification expressions involving *all*, an element whose status as a true universal quantifier is subject to much debate (see Brisson 1998 for discussion).

Whatever the explanation for this result, it nevertheless raises important questions concerning the representation of scope in both monolingual and bilingual speakers. However, Lee et al. (2011) did not test the scope preference of their bilingual subjects in the Korean language. Since that language was, at the time of the study, the weaker of the two in the subjects’ bilingual representation, it is important to determine whether the scope preferences observed in monolingual Korean are still present in that language when it is weakened by a dominant L2. In addition, the authors tested a rather small group of speakers (seven adults and nine children).

In this paper, we further address the question of scope in bilinguals by comparing doubly-quantified sentences in Mandarin Chinese (henceforth Mandarin), English, and heritage Mandarin; “heritage Mandarin” refers to the language spoken by early sequential bilinguals who learned Mandarin before English but are dominant in English at the time of testing. We focus on these three populations because they present an interesting comparison case: English is known to have scope ambiguities, while Mandarin is generally assumed to have only surface scope (although this assumption has recently been contested by Zhou and Gao 2009; see

Scontras et al. to appear for discussion). Meanwhile, the nature of scope calculations in the Mandarin of the English-dominant bilinguals is unknown.

The rest of our paper is structured as follows. Section 2 presents and analyzes scope relations in Mandarin; in particular, we follow Scontras et al. (to appear) in refining the conditions under which such scope relations should be tested, and show that Mandarin does indeed have surface scope only. Section 3 presents an experiment in English which follows the same design as the Mandarin experiment. Finally, section 4 presents a study of scope in Mandarin as spoken by heritage bilinguals. We discuss our main results and present the directions for further study in section 5.

2 Experiment 1: Mandarin

We take as our starting point the finding from Scontras et al. (to appear) that English allows inverse scope in doubly-quantified sentences, whereas Mandarin does not. We begin by motivating the current experiments in light of this finding.

In his seminal work, Huang (1982) argues that Mandarin does not display scope ambiguity (see also Huang 1981): if one quantificational expression c-commands the other one in its surface configuration, then that c-command relation is preserved at LF. Sentence (4), therefore, has only one reading, according to which none of the contextually relevant students came. Other scope readings are not possible.

- (4) Mei-yi-ge xuesheng dou mei-you lai.
 every-one-CL student all not-have come
 ‘Every student did not come.’

While this claim from Huang (1982) has survived in the theoretical literature for three decades, it was not experimentally examined until recently by Zhou and Gao (2009), who came to a different conclusion. Zhou and Gao tested the following configuration for doubly-quantified sentences in Mandarin, where the subject contains a universal quantifier and the object an existential quantifier.

- (5) Mei-ge ren dou qu-le yi-jia gongchang.
 every-CL person all go-ASP one-CL factory
 ‘Everyone went to a factory.’

In their experiment, participants (from Beijing) were provided with one of two possible context scenarios for each test sentence and asked to rate, on a 5-point scale, how well the sentences described the scenarios. In the case of (5), one scenario featured three different factories and each person went to a different factory. In the second scenario there was only one factory, and everyone went to it. The scenarios are meant to satisfy one of two possible scope interpretations for the test sentence. The first, many-factory scenario corresponds to surface scope (‘every’ > ‘a’); the second, single-factory scenario corresponds to inverse scope (‘a’ > ‘every’). Zhou and Gao’s results show that although the surface scenarios are rated more highly, both scenarios receive relatively high ratings.¹ Zhou and Gao thus conclude that doubly-quantified sentences in Mandarin (like (5)) are actually scopally ambiguous, permitting both surface and

¹Zhou and Gao examined, for each scope interpretation, three different types of verbs (action, locative, and psych-verbs), and found that the mean ratings of inverse scope were higher than 3 (out of 5) across all verb types.

inverse interpretations.

However, the design of Zhou and Gao’s study faces a serious problem: we cannot tell whether their stimuli indeed allow inverse scope interpretations. This is because the inverse scope reading in (5) entails the surface scope reading (see Reinhart 1976, 1997, Ruys 1992, Abusch 1994, and more recently Meyer and Sauerland 2009): if there is a single factory that every person went to, then it is necessarily true that every person went to a factory. In other words, both scenarios mentioned above are compatible with the surface scope reading of (5); that everyone went to the same factory is not inconsistent with a surface parse of the sentence. Therefore, whether (5) is ambiguous remains unknown, and Zhou and Gao’s conclusion from is not supported by their experimental findings.

Data that can demonstrate genuine inverse scope without the entailment problem just described are those like (6), where a singular indefinite c-commands a universal quantifier in the surface structure. In this case, the inverse reading does not entail the surface scope: where there are multiple factory-goers, the inverse parse will be true while the surface parse is false.

- (6) A person went to every factory.

Inverse scope reading: For every factory, there is a person that went to it.

In Scontras et al. to appear, we tested precisely this configuration in Mandarin using a truth-value judgment task, and found a lack of inverse scope availability for Mandarin speakers: none of our 19 subjects judged inverse conditions true. Recent work has demonstrated that heritage speakers, whose judgments are less sure, respond better to scalar than to binary tasks (Orfitelli and Polinsky 2013). Given that our present aim is to investigate the grammar of scope in heritage speakers, our first task is to replicate the findings from Scontras et al. (to appear) using a different method: acceptability ratings.

2.1 Participants

132 subjects (from either Mainland China or Taiwan) participated in this experiment. We evaluated native language on the basis of two demographic questions: “What was the first language you learned?” (Mandarin) and “What is the language you speak most at home?” (Mandarin). Data from 53 native speakers were included in the analysis.

2.2 Materials

All materials come from Scontras et al. (to appear). We tested two types of doubly-quantified sentences: one where the subject contained ‘every’ and the object the indefinite/numeral ‘one’ (E>O), as in (7a), and one with the reverse configuration (O>E), as in (7b). Sentences were recorded by an adult male speaker of Mandarin from Beijing and normed to ensure neutral intonation.² Disambiguating pictures came from Benjamin Bruening’s Scope Fieldwork Project.³

- (7) a. Mei-yi-tiao shayu dou gongji-le yi-ge haidao.

every-one-CL shark all attack-ASP one-CL pirate

‘Every shark attacked a/one pirate.’





E>O

²We normed intonation to avoid prosodic disambiguation of scope configurations. However, Leddon et al. (2004) show that prosody does not provide reliable cues for disambiguating scope interpretations, at least in English.

³<http://udel.edu/~bruening/scopeproject/scopeproject.html>

Figure 1

An example item, Experiment 1 (Mandarin)

	Surface scope	Inverse scope
E>O	 <p><i>Mei-yi-tiao shayu dou gongji-le yi-ge haodao.</i> every-one-CL shark all attack-ASP one-CL pirate 'Every shark attacked a/one pirate.'</p>	 <p><i>Mei-yi-tiao shayu dou gongji-le yi-ge haodao.</i> every-one-CL shark all attack-ASP one-CL pirate 'Every shark attacked a/one pirate.'</p>
O>E	 <p><i>You yi-tiao shayu gongji-le mei-ge haodao.</i> exist one-CL shark attack-ASP every-CL pirate 'A/One shark attacked every pirate.'</p>	 <p><i>You yi-tiao shayu gongji-le mei-ge haodao.</i> exist one-CL shark attack-ASP every-CL pirate 'A/One shark attacked every pirate.'</p>

- b. You yi-tiao shayu gongji-le mei-yi-ge haodao.
exist one-CL shark attack-ASP every-one-CL pirate
'A/one shark attacked every pirate.'

O>E

We manipulated two factors, ORDER and SCOPE. Order corresponds to the linear configuration of quantifiers, that is, whether the surface structure is E>O ('every' over 'one/a') or O>E ('one/a' over 'every'); scope corresponds to the intended interpretation, that is, whether the co-occurring picture depicts the surface or inverse scope reading. An example item is given in Figure 1.

2.3 Design

Participants took the experiment online using the web-based experiment platform Experi-RT (Becker and Levine 2010, Pilot et al. 2012). They began by filling out a demographic survey, then completed a training session consisting of three slides. The training items served to ensure that the sentences and pictures were correctly displayed and that participants understood the instructions as well as the correspondence between the sentence and the picture.

In each trial, a picture was shown first and the participants were asked to click on an audio button below the picture to play the sentence. After hearing the sentence, they were asked to judge whether the sentence they heard appropriately described the picture using a 7-point

scale (1 = ‘completely inappropriate’, 7 = ‘completely appropriate’). Participants completed 16 trials in a random order (8 critical items and 8 fillers). Only one version of each test item was presented to any given subject.

2.4 Results

Averaged ratings for each of the four conditions are given in Table 1. We fit a mixed logit model predicting response by order, scope, and order/scope interaction. The model included random intercepts for participants and items and random slopes for order and scope grouped by participant and item. There was a significant effect of order ($\chi^2(1)=19.2$, $p<0.01$): the E>O configuration received higher ratings than O>E. We also found a significant effect of scope ($\chi^2(1)=21.6$, $p<0.01$): inverse scope conditions received lower ratings than surface scope.

Table 1

Average response by condition (Experiment 1: Mandarin)

order	scope	rating
E>O	surface	6.4
O>E	surface	4.7
E>O	inverse	3.7
O>E	inverse	1.6

2.5 Discussion

Recall that the E>O + inverse condition does not reliably probe the existence of inverse scope because whenever the sentence *every shark attacked one pirate* holds true on its inverse interpretation, the surface interpretation holds true as well. The critical test case is the O>E + inverse condition, where, for example, the participants saw a picture of multiple sharks attacking different pirates individually and heard the Mandarin sentence ‘one shark attacked every pirate’. Crucially, this condition received the lowest ratings, demonstrating the infelicity of inverse scope for Mandarin speakers and replicating the finding from Scontras et al. (to appear). Were inverse parses a viable option (as is claimed in Zhou and Gao 2009), we would expect ratings for this condition to be well above the floor level. To repeat: the acceptability of inverse scope in Mandarin was rated on average 1.6 out of a possible 7 points.

We also found that the O>E order received lower ratings than E>O regardless of scope interpretation. We interpret this effect as demonstrating the degraded status of universally quantified phrases in object position. This might have to do with the fact that in Taiwanese, a southern Chinese language spoken in Taiwan, definite/specific expressions are banned in postverbal position in several constructions (James Huang, p.c.; Teng 1995 and references therein). If we take a universal quantifier containing *every* to be definite/specific in a broad sense, as it typically requires a restricted domain of quantification, the dispreference for the O>E order may be seen as a consequence of cross-linguistic influence. We return to this point in our discussion of the English results in section 3.4.

Finally, we remark on two features of the Mandarin quantified sentences used in this experiment. First, in sentences with a numeral subject, the existential predicate *you* ‘exist’ is required before the numeral; see (7b). If we assume that *you* is a verb meaning ‘exist’ or ‘have’ (following the recent proposal by Fang and Lin 2008 and Fang 2010), sentences like (7b) re-

ceive an embedding, bi-clausal structure where the numeral subject is actually the object of *you* ‘exists’ and the rest of the sentence is a relative clause modifying the numeral subject. In other words, *you* sentences receive a structure that resembles that of English *there*-existential constructions. We will take this point into account in the design of the English experiment in section 3, where existential *there*-sentences will be examined.

Second, Mandarin does not have an article system: we have been translating English *a* as Mandarin *yi* ‘one’, but it is not obvious whether the singular numeral *yi* is semantically ambiguous between an indefinite article and a true numeral expression. We therefore do not know whether *yi* contributes merely existential force (like *a*), or whether it behaves always as a full-fledged numeral (like *one*).⁴

To better understand the potential contributions of these properties of the stimuli to the significantly degraded status of inverse scope in Mandarin, we conducted a second experiment using the same set of materials. In this experiment, we focus on English, a language uncontroversially claimed to allow inverse scope.

3 Experiment 2: English

Experiment 2 allows for a comparison between scope interpretations in Mandarin and English doubly quantified sentences. Again, we replicate a parallel study conducted by Scontras et al. (to appear), but replace the original binary task with a scalar task. We split this experiment into four sub-experiments according to whether the head of the singular indefinite is the article *a* or the numeral *one*, and whether sentences in the O>E configuration participate in a *there*-existential.

3.1 Participants

We recruited 130 participants via the Mechanical Turk Crowdsourcing Service of amazon.com. Participants were compensated for their participation. Only native speakers of English (n=114) were included in the analysis.

3.2 Materials

All items come from Scontras et al. (to appear). As in Experiment 1, we manipulated two factors, ORDER (E>O or O>E) and SCOPE (surface or inverse). Test sentences were translations of the Mandarin stimuli used in Experiment 1. Direct translation was not possible given the language-specific properties discussed above (i.e. universal *dou*, existential *you*, and the article/numeral *yi*). We therefore used four English constructions as targets for translation. A set of example sentences for the O>E configuration is given in (8).

⁴ Another property of the Mandarin stimuli which we are unable to address in the current study concerns the particle *dou*. When a subject or preverbal phrase contains *mei* ‘every’, the particle *dou* ‘all’ must appear in a VP-adjacent position; see (7a). *Dou* is a VP-external particle generally obligatory with a strong NP subject like *every student*. When the strong NP is an object (see (7b)), *dou* does not appear. The nature of this particle has been the subject of much debate, with many authors treating it as a universal quantifier of some sort (e.g. Huang 1982, Lee 1986, Cheng 1991). This move leads to the question of why strong NP subjects require the company of this universal quantifier.

(8)	Sub-experiment	Example
a.	A	A shark attacked every pirate.
b.	ONE	One shark attacked every pirate.
c.	THERE-A	There is a shark that attacked every pirate.
d.	THERE-ONE	There is one shark that attacked every pirate.

Sentences were recorded by an adult male speaker of American English and normed to neutral intonation. 5 fillers were added to the 8 critical items and 8 fillers from Experiment 1.

3.3 Design

Experiment 2 featured the same design as Experiment 1. Participants first filled out a demographic survey and then entered the training phase. They began with a training session of three slides. In each trial, a picture was shown first and the participants were asked to click on a button to play the sentence. They were then asked to judge whether the sentence they heard was acceptable in the context of the picture displayed. Subjects used a 7-point Likert scale for ratings (1 = ‘completely unacceptable’, 7 = ‘completely acceptable’). Subjects completed a total of 21 trials (8 critical items and 13 fillers).

3.4 Results

For the purpose of analysis, we split the results into four sub-experiments corresponding to the syntactic frame in (8) used to translate the original Mandarin. All results are given in Table 2.

We begin with the A sub-experiment, which featured sentences containing indefinite *a* and no *there*-existential, (8a). We fit a mixed logit model predicting response by order, scope, and their interaction (analyses were identical to Experiment 1). We found a significant effect of order ($\chi^2(1)=6.50$, $p<0.05$): O>E sentences received lower ratings than E>O sentences. We also found a marginal effect of scope ($\chi^2(1)=3.28$, $p=0.07$): inverse conditions received lower ratings than surface conditions.

Table 2

Rating responses by condition of Experiment 2 (English)

order	scope	A	ONE	THERE-A	THERE-ONE
E>O	surface	6.5	6.6	–	–
O>E	surface	5.6	6.2	6.2	6.5
E>O	inverse	5.5	5.6	–	–
O>E	inverse	4.5	2.1	3.1	2.3

For the ONE sub-experiment, (8b), we found significant effects of order ($p<0.01$) and scope ($p<0.01$), as well as a significant interaction between the two ($p<0.01$). Inverse conditions were rated lower than surface conditions, O>E lower than E>O, and O>E inverse lower than we would expect based solely on the combined main effects.

With the THERE-A sub-experiment, (8c), no order manipulation was possible; only the O>E configuration enters into a *there*-existential (cf. **There is every shark that attacked a pirate*). We therefore analyzed only the effect of scope, which was significant ($p<0.01$): the O>E inverse condition was rated lower than O>E surface.

As with the THERE items, in the THERE-ONE sub-experiment, (8d), no order manipulation was possible. We found a significant effect of scope ($p<0.01$): O>E inverse was rated lower than

O>E surface.

3.5 Discussion

The pattern of results found in the English A sub-experiment with indefinite *a* and no *there*-existential is similar to that found for Mandarin in Experiment 1: the O>E configuration is degraded relative to E>O, and inverse conditions are dispreferred.⁵ While in Mandarin the dispreference for O>E may be explained in terms of language contact, there is no comparable motivation for such a dispreference in English. The degraded status of the O>E configuration in both English and Mandarin argues against the language contact hypothesis considered in section 2.5. It remains to be seen how common the O>E dispreference is cross-linguistically, and why.

On the other hand, the ratings for the critical condition (O>E + inverse) are markedly different across the two languages: 1.6 (Mandarin) vs. 4.5 (English). This finding confirms the current consensus that English allows inverse scope while Mandarin does not (replicating Scontras et al. to appear, *pace* Zhou and Gao 2009).

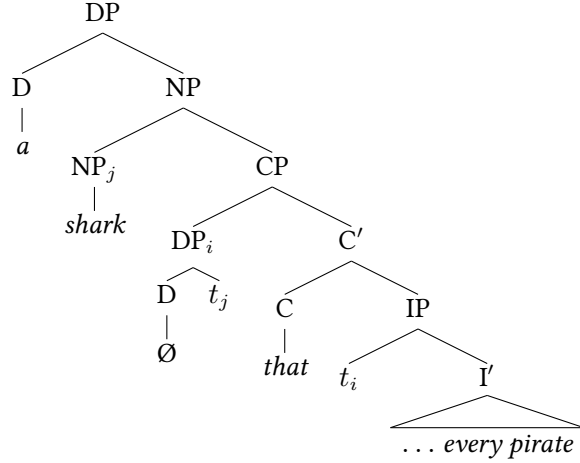
In addition, two properties of the English data deserve further attention. First, in the ONE and THERE-ONE sub-experiments, inverse scope is less preferred than in the A and THERE-A sub-experiments. One might hypothesize that this result derives from the fact that the English numeral *one* has a stronger tendency to be interpreted as specific/wide-scope-taking than is indefinite *a*, perhaps due to some competition between the two lexical items. But if *one* is always interpreted as specific, taking wide scope, then we should find a decrease in the ratings for E>O + surface conditions for this item: *one* corresponds to many objects in these scenarios (cf. Figure 1). This is not what we find. In object position, *one* readily accepts narrow scope, which means it is not interpreted as specific. A more likely explanation is that *one* is subject to the *single reference principle* (Fodor 1982, Kurtzman and MacDonald 1993) to a higher degree than *a*: upon hearing *one*, English speakers want to associate it with a single entity (see Scontras et al. to appear for a similar finding and fuller discussion). But upon hearing *one* in object position following *every*, speakers have evidence against the single reference interpretation, resulting in the positional differences we report here: only in subject position must *one* be interpreted as specific.

Second, the results of the O>E + inverse condition shed new light on the syntactic analysis of English *there*-existentials. On the surface, *there*-existentials have an embedding bi-clausal structure [_{CP} *there be* [[_{DP} *head noun*] [_{CP} *relative clause*]]]. In the doubly quantified sentences tested in this study, one quantifier phrase is base-generated as the object of *be* and the other inside the relative clause (RC), for example, *there is a shark* [_{RC} *that attacked every pirate*]. Assuming QR is clause-bound, the RC object *every pirate* cannot move out of the RC that embeds it. One way to get the inverse scope reading (*every* > *a*) is for the head NP, *shark*, to be base-generated inside the RC and then to move out, as schematized in (9). This raising approach allows *shark* to be reconstructed back into the embedded clause at LF, where it may be scoped over by *every*. Raising plus reconstruction thus gives rise to inverse scope readings for *there*-existentials. On the contrary, under an operator movement account (e.g. Chomsky 1977), what is moved inside the RC is an implicit operator; the head NP *shark* originates outside of the RC,

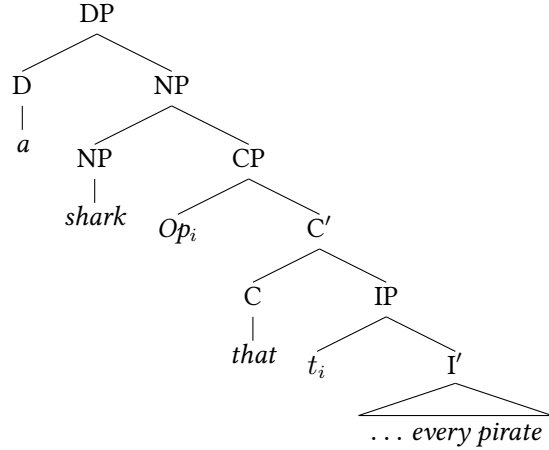
⁵The lower ratings given to English inverse conditions across all sub-experiments, regardless of word order, are consistent with previous studies on English scope interpretation (e.g. Tunstall 1998, Anderson 2004). We return to this point in our discussion of Experiment 3.

as in (10). Since there is no way to reconstruct the head NP into the RC, *every* cannot scope over it (due to locality conditions) and inverse scope is thus predicted to be impossible.

- (9) *head-raising analysis:*
reconstruction of *shark* possible



- (10) *operator movement analysis:*
reconstruction of *shark* impossible



If speakers of English employ only the operator movement strategy, scope ambiguity should not be observed for relative constructions; if they adopt the head-raising strategy, scope ambiguity may or may not arise, depending on whether reconstruction of the head NP has taken place. Scontras et al. (to appear) report truth-value judgments for the same stimuli used in the current experiment. In that study, subjects demonstrated no difference in their willingness to accept inverse scope in the plain A items, and in the bi-clausal THERE-A existentials (56% true responses for A; 50% true responses for THERE-A). This finding is interpreted by Scontras and colleagues as supporting a raising analysis of English RCs, which would yield the observed availability of inverse scope on the basis of reconstruction. In the current experiment, we find higher ratings for the biclausal THERE-A items than Scontras et al. did, but these ratings are a full point lower than the ratings for the mono-clausal A items (cf. Table 2). We believe two factors contribute to this decrease in perceived acceptability: the difference in the nature of the task, and complexity.

In Scontras et al. (to appear), the task was to provide truth judgments. If the sentence could

describe the co-occurring image, subjects were instructed to judge it as true; therefore, as long as the inverse scenario was possible, no matter how improbable, truth judgments had to be available. In the current study, the task was to provide ratings. Computing inverse scope is a costly operation, and this cost is reflected in the ratings that the inverse conditions received (Anderson 2004). In other words, the task of providing truth judgments is more likely to force the costly operation of reconstruction than is the task of providing acceptability ratings. In addition, complexity in general, and clausal complexity in particular, is known to affect processing, which is reflected in acceptability ratings (see Gordon and Lowder 2012 for discussion). It should therefore come as no surprise that the biclausal *THERE-A* items are rated lower than the monoclausal *A* items. Still, our results, together with those reported in Scontras et al. (to appear), demonstrate the ability for scope interactions to cross a relative-clause boundary, a finding that supports the raising analysis of these constructions (Vergnaud 1974, Kayne 1994, Aoun and Li 1993).

To summarize, using data from doubly quantified sentences, our study has demonstrated (i) that Mandarin does not exhibit inverse scope (contra Zhou and Gao 2009); (ii) that English does allow inverse scope, (iii) that the numeral *one* evidences a processing effect wherein single-referent parses are built early; and (iv) that English prefers to avoid inverse scope when a quantifier is embedded inside a relative clause (cf. Scontras et al. to appear). Our next question is what happens when the two grammars, English and Mandarin, meet. We turn now to heritage Mandarin.

4 Experiment 3: Heritage Mandarin

Having replicated the finding that English permits inverse scope while Mandarin prohibits it, we now test the robustness of this prohibition in Mandarin. To do so, we investigate the grammar of heritage speakers of Mandarin, that is, individuals who spoke Mandarin in childhood, can understand and speak it to some degree still, but are now more comfortable in their dominant language, American English.⁶ Demographically, this group is most comparable to the group investigated by Lee et al. (2011) for Korean. Essentially, our goal in this experiment is to test the degree to which the Mandarin prohibition is susceptible to interference from a dominant language. To do this, we replicate Experiment 1 on a population of heritage Mandarin speakers.

4.1 Participants

We recruited 21 heritage speakers of Mandarin. These speakers learned Mandarin as their first language, but currently live in the United States and are English-dominant (e.g. they speak English mostly at home).

4.2 Materials and Design

As in the previous experiments, we tested two types of doubly quantified sentences and manipulated two factors, *ORDER* (*E>O* or *O>E*) and *SCOPE* (surface or inverse). All stimuli and pictures were identical to those in Experiment 1, but the written instructions were given in English (identical to those in Experiment 2). Subjects rated the acceptability of the sentences they heard in the context of the scenarios depicted in the co-occurring images. Subjects completed

⁶For a general overview of heritage languages and their speakers, see Benmamoun et al. 2013a,b.

16 trials (8 critical items and 8 fillers).

4.3 Results

We present the results of heritage Mandarin in parallel with those from native Mandarin in Experiment 1 (Table 3). We fitted a mixed logit model predicting response by order and scope, together with the factor NATIVENESS (heritage vs. native); we also included their interactions. We found significant effects of order ($p < 0.01$) and scope ($p < 0.01$): across the two groups, the O>E configuration received lower ratings than E>O, and the inverse conditions received lower ratings than the surface conditions. We also found a significant effect of nativeness ($p < 0.01$): native Mandarin speakers gave lower ratings than heritage speakers. There is marginal interaction between nativeness and scope ($p = 0.07$): native speakers rated inverse conditions lower than heritage speakers.

Table 3

Average ratings by condition for Experiment 3 (heritage vs. native Mandarin)

order	scope	HERITAGE	NATIVE
E>O	surface	6.9	6.4
O>E	surface	5.2	4.7
E>O	inverse	4.8	3.7
O>E	inverse	2.8	1.6

In addition to the ratings, we also recorded reaction times (measured from the end of the audio file to the point at which subjects provided their ratings); results are presented in Table 4. We found significant effects of order ($p < 0.01$) and scope ($p < 0.01$): across both groups, responses to O>E configurations took longer than those to E>O, and responses to inverse scope took longer than responses to surface scope. We also found a significant interaction between order and scope ($p < 0.05$): responses to O>E inverse conditions were faster than we would expect on the basis of the combined effects. Finally, there was marginal interaction between order and nativeness ($p = 0.09$): native speakers were faster on O>E configurations than heritage speakers.

Table 4

Reaction times (ms) by condition for Experiment 3 (heritage vs. native Mandarin)

order	scope	HERITAGE	NATIVE
E>O	surface	3706	4014
O>E	surface	7120	5728
E>O	inverse	6167	5640
O>E	inverse	7941	5678

4.4 Discussion

Recall the finding from Lee et al. (2011) on scope in heritage Korean: speakers who were dominant in English nevertheless demonstrated scope behavior characteristic of their weaker language, Korean. Moreover, this scope behavior evidenced a simpler system that avoided ambiguity. In this context, let us consider the current results.

Important for our present purposes is the fact that the heritage group rated the critical inverse condition higher than the native group did (2.8 vs. 1.6), and took longer to provide

these ratings than the native group (7941ms vs. 5678ms). The slower reaction times for heritage speakers suggest that these participants were puzzled by the sentence-picture pairs for this condition.

Although the heritage group gave higher ratings than the native group to the inverse conditions, it bears noting that the heritage speakers rated *all* conditions higher. Moreover, when we compare the responses of English and heritage Mandarin speakers, we find that the two groups are doing different things with inverse scope: English speakers rated inverse scope on average 4.5 out of 7 points, compared to 2.8 from heritage Mandarin. We take these facts as suggesting that the heritage participants did not employ inverse scope to resolve the interpretation. The higher ratings for inverse conditions (relative to native speakers) stems instead from the “yes-bias”: heritage speakers are known to rate unacceptable/ungrammatical sequences higher than native controls (Benmamoun et al. 2013b, Laleko and Polinsky 2013). Heritage speakers respond differently from native ones in avoiding the lower end of the rating scale when judging ungrammatical sentences. In other words, when our heritage speakers heard a sentence that did not match the picture in the critical condition, they were less certain, and eventually gave higher ratings than the native speakers. This hypothesis is further supported by the reaction times, which show that heritage participants took more time to judge the critical items than all other conditions. This pattern contrasts with that of the native group, whose reaction times across all conditions were more uniform.

But if heritage Mandarin speakers do not allow inverse scope, does it follow that they have a robust Mandarin grammar? Not necessarily. Heritage grammars are less dominant and more costly to employ. Heritage speakers might therefore prefer simpler grammars. Suppose that QR is the mechanism by which we achieve inverse scope. A grammar with QR will be more complex than one without it: in addition to implicating an additional grammatical mechanism, it will produce more ambiguities. The heritage Mandarin speakers we tested are thus likely to adopt the Mandarin-like system because it is simpler, perhaps along the lines of the following principle from Anderson (2004):

- (11) *Processing Scope Economy* (Anderson 2004:31)
The human sentence processing mechanism prefers to compute a scope configuration with the simplest syntactic representation (or derivation). Computing a more complex configuration is possible but incurs a processing cost.

Put differently, a Mandarin-like grammar for scope is adopted by the heritage speakers not because this heritage grammar never undergoes interference but because it happens to be a simpler one than the speakers’ other available grammar (i.e. English). To fully test this hypothesis, it will be necessary to investigate how Mandarin-dominant heritage speakers of English respond to doubly quantified sentences (in English). If the principle in (11) is applicable to a two-language system and the simpler, Mandarin-like grammar is always an option, we would expect these speakers to assign OE + inverse sentences lower ratings than native English speakers; that is, they should lose the ability for inverse scope because the rigid scope grammar is simpler. This seems to be what Lee et al. (2011) found for English-dominant speakers with early exposure to Korean. The confluence of evidence suggests that bilinguals prefer simpler, less ambiguous grammars for scope – a preference visible in both the weaker and the dominant language. We fail to find interference from a dominant language when its system is more complex than the alternative.

5 General Discussion

The general question that inspired this study was: do bilingual speakers show interaction between the languages they speak in their calculation of scope? In other words, does the grammar of scope from one language influence how scope calculations proceed in the other? If yes, what is the direction of such interference, and are there constraints on it? While we have so far taken only the first step in the direction of addressing this question, the answer appears to be a qualified no. In our study, we tested speakers of Mandarin dominant in English. English possesses a more complex system than Mandarin for calculating scope in doubly quantified sentences: the availability of QR delivers ambiguity between surface and inverse scope. In Chinese, no such ambiguity is found. Were English, the dominant language, to influence the weaker language, we would expect these heritage speakers to show evidence of scope ambiguity. Crucially, we do not observe any such ambiguity: the heritage speakers remain faithful to the baseline grammar, prohibiting inverse scope.

5.1 Conclusions

We began with Lee et al.’s (2011) observation that English scope calculations may be simplified in English-dominant heritage speakers of Korean. We interpret this finding as evidence that, when the unambiguous Korean system meets the ambiguity-generating English system, the result is diminished ambiguity. To further our understanding of the scope representation of bilingual speakers, we explored the treatment of doubly quantified sentences in heritage Mandarin speakers dominant in English. We chose this pair of languages because previous work indicates that English allows inverse scope in doubly quantified sentences while Mandarin does not (see Scontras et al. to appear).

Why Mandarin and English have diverging scope possibilities is far from clear. Mandarin makes use of a preverbal quantificational particle *dou* (often glossed as ‘all’) when the subject of a sentence contains a strong quantifier. As *dou* has no close counterpart in English, it seems plausible to hypothesize that it is this creature that leads to a difference between E>O sentences in Mandarin and English, especially in light of the ratings in the E>O + inverse condition (3.7 in Mandarin vs. 5.5 in English A). As for O>E sentences, the existential *you* ‘exist’ predicate, the presence of which is generally obligatory with indefinite subjects in Mandarin, may be a crucial syntactic clue. It remains to be seen whether *you* signals a bi-clausal configuration for O>E sentences, as English *there*-existentials do, but disallows head-raising, rendering reconstruction unavailable.

Our findings indicate that heritage Mandarin speakers continue to adhere to surface scope in their processing of Mandarin. However, there are at least two possible explanations for this result. One possibility is that there is no transfer from the stronger language to the weaker language in the scope domain.⁷ The other possibility is that, when two systems meet, the result is reduction of ambiguity and simplification. Such simplification has been independently observed in other linguistic phenomena under language contact (see Camacho and Sanchez 2002, Pfaff 1981, Romaine 1992, Silva-Corvalan 1991, Thomason and Kaufman 1991 and Trudgill 2002). Whatever the explanation, we do not observe heritage Mandarin speakers applying

⁷Note that we do observe transfer from dominant languages in other domains. For example, Ionin et al. (2011) find semantic transfer: heritage speakers accept bare plurals in subject position as grammatical in Spanish, and interpret the definite article as having a specific interpretation more often than a generic interpretation. See Benmamoun et al. (2013a,b) for further discussion.

their English grammar in scope calculation.

The principle of Processing Scope Economy (Anderson 2004) shown in (11), which maintains that human sentence processing prefers the simplest representation/derivation in computing a scope configuration, offers an explanation for our findings. That is, a Mandarin-like grammar for scope is adopted by the heritage speakers not because their heritage grammar never undergoes interference, but because the Mandarin system, which lacks inverse scope, happens to be a simpler system than the English system. To fully test this hypothesis, it would be necessary to investigate the behavior of heritage speakers whose linguistic system is the opposite of the one addressed in the present study: that is, how do heritage speakers of a language allowing scope ambiguity (e.g. English), whose dominant language only allows surface scope (e.g. Mandarin), respond to doubly-quantified sentences in their weaker language? If the principle in (11) is applicable to a two-language system and the simpler, ambiguity-free scope grammar is always an option, we would expect such heritage speakers to lose inverse scope and stick with the simpler, rigid-scope grammar. In our experimental paradigm, these speakers would assign OE + inverse sentences significantly lower ratings than native English speakers.

It should be noted that, throughout our experiments, it is the O>E + inverse condition that serves as the diagnostic for inverse scope. Because inverse scope does not entail surface scope in this configuration (i.e. existential > universal), it is free from the entailment problem associated with doubly-quantified sentences involving *every* and indefinites. Although this problem has long been noted (since at least Reinhart 1976), it has not been taken into serious consideration in the theoretical literature on Mandarin quantification, to the best of our knowledge. This has consequences which leads us to our final topic, concerning outstanding theoretical issues in Mandarin quantification.

5.2 Open Issues

Two important problems in Mandarin quantification do not immediately lend themselves to experimental testing. The first concerns quantification in passive sentences. Aoun and Li (1989:146–147) claim that passive sentences such as (12) are ambiguous in the same way as the English sentence *Someone is loved by everyone*. In other words, the authors claim that passive sentences are exceptions to the general rigid scope requirement in Mandarin.

- (12) mei-ge ren dou bei yi-ge nuren zhuazou le.
 every-CL person DOU PASS one-CL woman arrested ASP
 ‘Everyone was arrested by a woman.’

Therefore, it is difficult to argue unequivocally for the existence of the inverse-scope reading in (12), because this reading entails the surface scope interpretation: if there is a single woman that arrested everyone, then it is necessarily true that everyone was arrested by a woman, albeit the same one; the latter scenario does not justify an inverse-scope interpretation.

An obvious way to avoid the entailment problem when testing doubly quantified sentences is to use quantifiers of other types, for example, *These sharks did not attack a/one pirate*, where the relevant quantificational expressions are negation and a singular indefinite, and the inverse scope reading in the present experiment does not entail surface scope. We did not use such sentences as stimuli because, for unknown reasons, quantifiers in Mandarin sound awkward when they are objects below negation. If *These sharks did not attack a/one pirate* in Mandarin is grammatical at all, the interpretation has the singular expression contrastively focused, im-

plying it is not the case that these sharks attacked one pirate, but rather two pirates or more. Strong quantifiers (e.g. ‘every’, ‘most’, ‘all’) show a similar pattern under negation in Mandarin.

The second outstanding issue in Mandarin quantification has to do with the scope of numerical expressions. Jiang (2012:112–113) cites examples like (13) and (14) and claims that the numeral indefinites therein show exceptional wide scope with respect to an adjunct *if*-clause and another numeral indefinite. Hence, they are ambiguous in terms of scope interpretation (on a par with English indefinites).

- (13) ruguo ni neng dai yi-ge nusheng lai wode party dehua, wo hui hen kaixin.
 if you can bring one-CL girl come my party if I will very happy
 ‘If you can bring one girl to my party, I will be very happy.’
 a. Wide scope: *one girl* > *if*
 ‘There is a specific girl, if you can bring this girl to my party, I will be very happy.’
 b. Narrow scope: *if* > *one girl*
 ‘I will be very happy if you can bring any girl to my party.’
- (14) wo mai-le [NP wu-ben [san-ge ren xie] de shu].
 I buy-ASP five-CL three-CL man write DE book
 a. Wide Scope: *three men* > *five books*
 ‘There are three men *x* such that there are five books *x* wrote that I bought.’
 b. Narrow Scope: *five books* > *three men*
 ‘I bought five books that three men wrote.’

Again, we face the same problem of unambiguously identifying inverse scope. In this case, the problem resides in the fact that the conditional, (13), is felicitous regardless of whether there is one specific girl in the relevant context. On the narrow/surface scope reading (*if* > *one girl*), (13) is true as long as I will be happy in the situation when you bring one girl to my party. Whether I (the speaker) have a specific girl in mind is irrelevant—even if I do, the interpretation is still compatible with the narrow/surface scope reading. On the wide/inverse scope reading, on the other hand, (13) is true only when there is a specific girl that I am referring to, and it is false otherwise. This means that only the latter interpretation yields clues to the scope interpretation of *one girl*: if (13) can be judged *false* when there is no specific girl in the speaker’s mind, we can conclude that *one girl* indeed has a wide scope reading over the *if*-clause. However, given the phenomenon of *Truth Dominance* (Meyer and Sauerland 2009), it is very unlikely that a speaker would provide such a judgment, since the sentence has one reading that holds true of this scenario (i.e. the narrow/surface scope reading, which is the most accessible reading).⁸ Hence, (13) does not provide solid evidence for scope ambiguity.

In the discussion of (14), Jiang (2012: 113) remarks that “. . . the numeral ‘five’ c-commands the NC [numeral constructions] ‘three men’ in the complex NP, and both wide and narrow scope readings of ‘three men’ are available.” She provides two paraphrases corresponding to the two possible scope interpretations, as shown in (14) above. What Jiang seems to refer to by the term “wide scope” reading is, again, the specific interpretation of ‘three men’; thus, this scope reading corresponds to a scenario where the speaker of (14) has in mind three specific men such that I bought five books they wrote. But note that the wide/inverse scope reading

⁸The *Truth Dominance* constraint states that, “whenever an ambiguous sentence *S* is true in a situation on its most accessible reading, we must judge sentence *S* to be true in that situation” (Meyer and Sauerland 2009:140).

entails the narrow/surface scope reading: if there are three men who (cumulatively) wrote five books I bought, then it necessarily holds true that I bought five books (cumulatively) written by three men, albeit the same three. Thus the specific reading does not evidence true wide scope of ‘three men’ over ‘five books’. On the other hand, if (14) can be judged *false* in the scenario where each of the five books was written by a distinct three-man group, we can conclude that wide/inverse scope obtains, because in this scenario, the narrow/surface scope is true while the wide/inverse scope is false. However, speakers are unlikely to produce such a judgment for this type of scenario, because there is at least one reading where (14) is true. As a result, whether this example demonstrates true inverse scope or not cannot be conclusive.

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